

# Chemistry 129.01 - General Chemistry Workshop - Spring 2017

## Week #8

### **Friday, April 7.** Equilibrium Constant Applications and Le Châtelier's Principle

Assigned reading: Sections 13.3, 13.4

Today we will continue our discussion about chemical equilibrium. We will work on more problems involving the equilibrium constant to determine the concentrations of reactants and products at equilibrium. Next week, we'll apply these equilibrium concepts to acid-base equilibria so that we can determine the pH of different solutions.

We will also discuss the Le Châtelier's principle. The Le Châtelier's principle is one of the most fundamental ideas behind chemical reactivity. This is our introduction to it and we will apply it again next week to common-ion strong and weak electrolyte solutions like buffers. The basic idea is simple – a chemical system shifts in response to perturbations to the system. What we need to understand is how we can perturb a system and how it will respond.

1. Define the following concepts and symbols:

Le Châtelier's principle

Exothermic Reaction

Endothermic Reaction

2. What kind of disturbance will result in a change to the value of the equilibrium constant, concentration, volume or temperature?
3. This is the ideal gas law,  $PV=nRT$  where P represents the pressure, V the volume, n the number of moles, T the temperature and R is the gas constant. Based on the ideal gas law equation, how is the pressure of a gas related to the volume of a gas? How is it related to the number of moles of gas? (Directly proportional or inversely proportional?).

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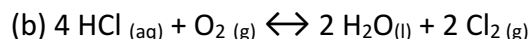
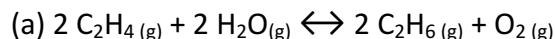
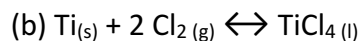
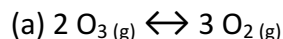
**Notes:**

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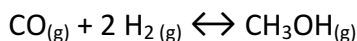
### Problem Set #9

Due Monday, April 10 (at the beginning of class). Late homework will not be accepted.

1. Write the equilibrium expressions ( $K_c$ ) for the following reactions and indicate whether the equilibrium is homogeneous or heterogeneous.

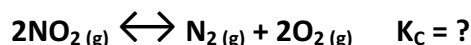


2. Consider the following reaction:

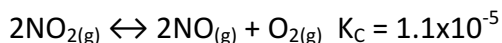


An equilibrium mixture in a 2.00L vessel is found to contain 0.0406 mol  $\text{CH}_3\text{OH}$ , 0.170 mol  $\text{CO}$ , and 0.302 mol  $\text{H}_2$  at 500K. Calculate  $K_c$ . Which reaction is favored (forward or reversed)?

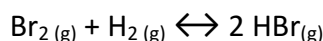
3. Find  $K_c$  for the following reaction:



Use the following data to find  $K_c$ :



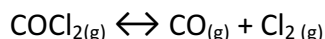
4. A mixture of 1.374g of  $\text{H}_2$  and 70.31g of  $\text{Br}_2$  is heated in a 2.50L vessel at 700K. These substances react as follows:



At equilibrium the vessel is found to contain 0.566g of  $\text{H}_2$ . Calculate the equilibrium concentrations of  $\text{H}_2$ ,  $\text{Br}_2$ ,  $\text{HBr}$  and  $K_c$ .

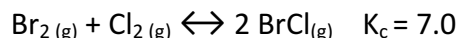
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5. At 100°C the equilibrium constant for the reaction



is  $2.19 \times 10^{-10}$ . Is a mixture containing the following concentrations at equilibrium:  $[\text{COCl}_2] = 2.00 \times 10^{-3} \text{M}$ ,  $[\text{CO}] = 3.3 \times 10^{-6} \text{M}$ ,  $[\text{Cl}_2] = 6.62 \times 10^{-6} \text{M}$ ? If not, indicate the direction that the reaction must proceed to achieve equilibrium.

6. Consider the following reaction at 400K:



If 0.25 mol of  $\text{Br}_2$  and 0.25 mol of  $\text{Cl}_2$  are placed into a 1.0L container, what will be the equilibrium concentrations of  $\text{Br}_2$ ,  $\text{Cl}_2$ , and  $\text{BrCl}$ ?

7. The following reaction is exothermic:  $2 \text{Cl}_{2(g)} + \text{C}_{(s)} \leftrightarrow \text{CCl}_{4(g)}$

- I. Predict the effect (shift right, shift left, or no effect) of the following:

- (a) Adding more  $\text{CCl}_4$  to the reaction mixture: \_\_\_\_\_
- (b) Increasing the temperature of the reaction mixture: \_\_\_\_\_
- (c) Adding more C to the reaction mixture: \_\_\_\_\_
- (d) Adding more  $\text{Cl}_2$  to the reaction mixture: \_\_\_\_\_
- (e) Decreasing the volume of the reaction mixture: \_\_\_\_\_
- (f) Adding a catalyst to the reaction mixture: \_\_\_\_\_

- II. Will the equilibrium constant of the reaction increase or decrease if the temperature is increased?